

5 In accordance with the present invention, as indicated above, a need exists to effectively deliver voice traffic on the Homenetworking (HPNA V2) network. Of note is the need to get the voice traffic to operate within performance goals within the HPNA V2 network. In particular, issues dealing with an A/D converter sampling circuit clock synchronization on the home network, and issues dealing with packet boundaries and when to take a set of
10 samples and call it a packet for use on the home network, need resolution.

15 Consider the application of voice data in conjunction with the home network, in general. How data is packaged and how higher layer information is communicated are issues which need to be addressed. When the home has a connection point (e.g., a gateway) to the public telephony systems, video / voice high speed data networks, and a phone service provider wishes to supply phone service along with high speed data, one technique is to provide a cable modem instead of having a traditional modem
20 for connection to an internet service provider (ISP). With the cable modem, a computer can be connected thereto to allow the user to have a very high speed data service. The high speed data service provider may also wish to provide video feeds, phone service over the same network. The cable modem could also contain
25 connection points to allow the phones in the home to be connected to the cable modem, that is, the analog phone signal goes into the cable modem and gets converted to appropriate digital signals for transmission from the cable modem to the public telephony network. U.S Patent Application 09/501,850 entitled "Cable Modem
30 System with Sample and Packet Synchronization", owned by the Assignee of the present application and incorporated herein by reference, describes such a system. When the HPNA V2 system is also employed in the home to provide local area network interconnection for the transfer of digital data, such HPNA
35 system can be connected to the cable modem. In turn, if the

now U.S. Patent No. 6,834,057

variable gain amplifier (VGA) 470, filter 480 for low-pass anti-aliasing, VGA 490, and is similarly coupled to phoneline connector 450 through electronic hybrid 440 and filter / transformer / electronic protection circuit 445. Electronic hybrid 440 and filter / transformer / electronic protection circuit 445 are connected therebetween by a plurality of transmit and receive lines (e.g., TX, RX1, RX2) 495. The operations of the analog front end are well known in the art.

Homenetworking PHY Layer Overview

In accordance with a preferred embodiment of the present invention PHY 320 uses 4 MBaud QAM modulation and 2 MBaud Frequency Diverse QAM (FDQAM), with 2 to 8 bits-per-Baud constellation encoding, resulting in a PHY-layer payload modulation rate that ranges from 4 Mb/s to 32 Mb/s. The modulation techniques are set forth in U.S. Patent Application No. 09/169,552 entitled "Frequency Diverse Single Carrier Modulation For Robust Communication Over In-Premises Wiring", which is incorporated herein by reference. Information is transmitted on the transmission medium / channel in bursts. Each burst or physical layer frame consists of PHY-layer payload information encapsulated with a PHY preamble, header and postamble. The PHY-layer payload in each physical frame is that part of the Ethernet Link Level frame that follows the Ethertype field through the Frame Check Sequence (FCS), plus a CRC-16 and a pad field for the 4 Mbaud rate. Hereafter, "payload" refers to the PHY-layer payload unless otherwise specified.

U.S. Patent No. 6,327,311

Referring to Fig. 5, a transmitter aspect of PHY 320 is shown in functional block diagram form. Transmitter 500 includes frame processor 510, data scrambler 520, bit-to-symbol mapper (constellation encoder) 530, and QAM / FDQAM modulator 540. The frame format transmitted by transmitter 500 is shown in Fig.6. Frame format 600 consists of low-rate header section 610, a

09/0267,884, the content of which are expressly incorporated by
 09/026,884 now U.S. Patent No. 6,256,317
 reference herein. Each station maintains eight Backoff Level (BL)

Reply frame, the receiver uses the demodulation statistics for this frame, and any previously received Rate Test Reply frames using this encoding, to make a decision as to the channel's capability to support the tested band encoding. If the decision is that the channel is not capable of supporting the tested band encoding, the receiver does not generate another Rate Test Request frame for at least 128 seconds. If the decision is that the channel is capable of supporting the tested band encoding, the receiver may repeat the test to collect more data, at a maximum rate of one RateTest Request frame every second, with a maximum of 16 additional tests. At this point, the receiver generates a Rate Change Request to the sender specifying the new band encoding. Support for Rate Test Reply frames is only required in stations that implement additional bands beyond Band1. Stations that only implement Band1 silently discard received Rate Test Reply frames. Whenever a transition to Compatibility mode occurs, the receiver PE is set to a value of 8 for all channels for a period of 60 seconds, to match the Sender nodes' behavior. Whenever a transition to V2 mode occurs, the receiver PE is set to a value of 1 for all channels.

The Link Integrity Function is now more fully described. In addition to the implementation aspects set forth hereinbelow, the concepts set forth in related U.S. Patent Application No. 09/619,553 entitled "A Method ^{co-pending} And Apparatus For Verifying Connectivity Among Nodes In A Communication Network", which is incorporated herein by reference. The purpose of the Link Integrity Function is to provide a means for hardware and/or software to determine whether or not this station is able to receive frames from at least one other station on the network. In the absence of other traffic, a station periodically transmits a Link Integrity Control Frame (LICF) to the Broadcast MAC address, with the interval between such transmissions governed by the method described below.

mapping, then it always uses the priority of the next lower valid mapping. Consider the following example. If the CurrentInuse, are
 5 [0,1,4,7], then the corresponding set of in-use PHY priorities is [2,0,4,6]. Then increase each by the number of missing higher priorities: 2->5, 0->4, 4->6 and 6->7. Just to be safe, the any unused PHY priorities are also remapped to the new value of the next lower in-use priority, giving: 1->4, 3->5, 5->6, 7->7. So
 10 the in-use LL priorities [0,1,4,7] result in transmitting PHY priorities [5,4,6,7]. A complete map for all the LL priorities adds the remaining remapped values for the default priorities corresponding to the unused LL priorities: LL[0,1,2,3,4,5,6,7] gives PHY[5,4,4,5,6,7,7].

15 Now turning to the Limited Automatic Repeat reQuest (LARQ) in more detail, the operation of which is set forth in pending U.S. Patent Application No.09/316,541 entitled "Limited Automatic Repeat Request Protocol For Frame-Based Communications Channels"^v which is incorporated herein by reference. This is a protocol
 20 that reduces the effective error rate when frame errors occur. Its primary distinction from similar, sequence number-based protocols is that it does not guarantee reliable delivery of every frame, but instead conceals errors in the physical layer through fast retransmission of frames. The goal is to
 25 significantly enhance the usability of networks that may, at least occasionally, have frame error rates (FER) of 1 in 10^{-2} or worse. Protocols such as TCP are known to perform poorly when FER gets high enough, and other applications, such as multi-media over streaming transport layers, are also susceptible to poor
 30 performance due to high FER conditions. The protocol provides a negative acknowledgment (NACK) mechanism for receivers to request the retransmission of frames that were missed or received with errors. There is no positive acknowledgment mechanism. There is no explicit connection setup or tear-down mechanism. A reminder
 35 mechanism gives receivers a second chance to detect missing

now U.S. Patent No. 6,335,933

present invention includes three functional aspects: (1) a channel
estimator, the concepts of which are described in co-pending
5 application No. 09/585,774, entitled "Method and Apparatus for
Efficient Determination of Channel Estimate and Baud Frequency
Offset Estimate" and which is incorporated by reference herein;
(2) a noise floor ^{now U.S. Patent No. 6,625,459} estimator; and (3) a unique field match (either
SRC or SI+SRC or SRC+DST or SI+SRC+DST).

10 In accordance with the present invention a method and
apparatus is provided for generating a preamble sequence to
facilitate channel estimation and noise floor estimation. A
sequence b is defined as the 16 symbols set forth below.

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$$\mathbf{b} = \begin{bmatrix} b_0 \\ b_1 \\ . \\ . \\ b_{15} \end{bmatrix} = \begin{bmatrix} 1+i \\ -1-i \\ -1-i \\ -1-i \\ 1+i \\ 1-i \\ 1+i \\ -1+i \\ 1+i \\ 1+i \\ -1-i \\ 1+i \\ 1+i \\ -1+i \\ 1+i \\ 1-i \end{bmatrix}$$

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This sequence has an important property that

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